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ABSTRACT

This report presents a case study of the renovation of Charles Young Elementary School in Washington, DC, focusing on how an improved school environment contributed to higher levels of educational performance. The school was chosen as a school revitalization demonstration project for the Urban Schools Initiative. The objective of the project was to: turn a school building with acute indoor environmental problems into a model school environment, assess the resources required for such work, train district personnel in the prevention of future indoor environmental quality problems, and provide guidance to other schools in environmental remediation. (Contains 43 references in an annotated bibliography.) (EV)

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HEALTHY SCHOOL ENVIRONMENT AND ENHANCED EDUCATIONAL PERFORMANCE

THE CASE OF CHARLES YOUNG ELEMENTARY SCHOOL WASHINGTON, DC

PREPARED FOR THE CARPET AND RUG INSTITUTE

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HEALTHY SCHOOL ENVIRONMENT AND ENHANCED EDUCATIONAL PERFORMANCE

INTRODUCTION

The 1997 renovation of the Charles Young Hill Top Academy in the District of Columbia is a classic illustration of how an improved school environment contributes to higher levels of educational performance. This case illustrates the connection between environmental quality, comfort, health and well-being, positive attitudes and behavior, and higher levels of educational performance.

This case shows that aging city schools do not have to be abandoned; they can be successfully revitalized and made contribute effectively to the process of education. Regardless of where a school is located, a healthy school environment is comfortable and secure from danger radiates a "sense of well-being" and a sends a caring message. These healthy school environments are the key to a high performance educational institution.

Successfully managing a school environment is a necessary and essential educational investment. Research increasingly shows that there is a clear link between environmental quality of schools and educational performance:

- Facility management systems determine environmental quality in schools.
- The quality of the school environment shapes attitudes of students, teachers and staff.
- Attitudes affect teaching and learning behavior.
- Behavior affects performance.
- Educational performance determines future outcomes of individuals and society as a whole.

In preparing this case, a variety of information and data were examined that were provided by an extensive review of educational facility publications, the Charles Young Elementary School, the University of North Carolina Environmental Studies Program, the US Environmental Protection Agency, the District of Columbia, and the Carpet and Rug Institute.

The key findings of the work start with the identifiable and measurable environmental conditions required of all high performance schools and the basic finding that an academically successful school must radiate a sense of well-being which is the essence of health. The information gathered for this case study clearly indicates there must be a serious, if not passionate, desire accompanied by positive action, to restore non-performing schools to a constantly healthy

state. Effective restoration is achieved through good design that addresses total environmental quality to include general sanitation, good air quality, noise control, lighting and glare reduction, soothing color, and general comfort provided by temperature and climate. The healthy school environment is kept in a steady state only with a thoughtfully organized cleaning and maintenance program. When a school environment is transformed from a state of hopeless deterioration to a healthy condition, attitudes of the students, teachers, parents, and surrounding community turn energetically positive so as to allow for effective teaching and learning.

ESSENTIAL ENVIRONMENTAL CONSIDERATION OF SCHOOLS

Research to date indicates productive, high performance schools manifest common traits (see annotated references in notes section):

- A high performance school seeks and provides adequate space and opportunities for students and teachers to spread out, reflect, interact, exchange information, examine and test ideas.
- The appearance of the school is inviting. Students, teachers, and the local community want it to be there.
- The school has adequate natural lighting that enhances productivity.
- The school strives for student-friendly conditions throughout the building.
- The school is inviting to good teachers and supports their retention.
- The school is designed to reduce stress. It is comfortable, has a consistent temperature, and manages noise.
- The school is clean and sanitary.
- The risk of an adverse health effect is very small.

Student and teacher comfort is indicated as the most important aspect of any school environment. If students are comfortable, then learning becomes much easier. Being comfortable is a combination of several different factors; adequate usable space, noise control, lighting, temperature and climate control, and sanitation.

The classroom is the most important area of a school because it is where students and teachers spend most of their time and where the learning process takes place. The following conditions help make the classroom a better place in which to learn.

Lighting in classrooms must focus on the front of the classroom and over the student's desks. Glare from hard surfaces is distracting and should be avoided wherever possible. The effective lighting of schools has been related to high performance test scores time and again.

Classes should be designed to accommodate students so that the number of students does not exceed 20. A lower density of students per classroom will increase teacher and student interaction and communication.

Classrooms must be designed with effective communication and interaction in mind. Students should be able to easily see and hear the instructor and other students. Noise must be controlled to levels that do exceed 68db. At about the 68 or 69 db noise level, students begin to have difficulty understanding what is being said and are distracted by noise in other classrooms.

Technology is at the center of the modern educational process, especially for mathematical and analytical skills. Computers in classrooms are very important. Tools, such as the Internet, allow the smooth exchange of information between student and machine, but must be positioned and used in environments that do not cause distraction. Increasingly, students can learn through virtual classrooms when no teacher is available. Comfortable surroundings aid in this form of learning.

Temperature and indoor climate is also important. A temperature of 68-72 degrees is ideal and should be maintained year round. Schools must be designed with good ventilation. Effective filters and cleaning must be functional so as to keep particulate matter, such as dust, out of the air. Odors can also be distract students, but can be removed with good ventilation.

The design of schools is a very important factor when dealing with sanitation related to moisture. Building roofs that leak or will not stop water are detrimental. Water in classrooms leads to mold which can cause allergic reactions. High humidity and standing water also creates an environment favorable to all kinds of bacteria, which can spread diseases.

The cleanliness of schools is also an important aspect of school environments. Clean schools not only lower the threat of the spread of illness, but also convey a caring message to the students and teachers. Cleaning and maintenance of schools is vitally important and is often underemphasized and underperformed. Students feel better going to clean classes and sitting in clean desks and surroundings. Sanitation in schools is important because young children face unique health hazards, especially respiratory infections, asthma attacks, skin disease, and diarrheal outbreaks.

A school environment should be one in which every student feels safe. We find promotion of safety by the increased installation of cameras and

monitoring devices throughout the school. Many schools today work with local law enforcement agencies to put security officers in schools. The presence of security officers often gives students a sense of safety and security.

In the final analysis, the primary environmental policy and management objective of every school facility should be that of taking whatever steps are necessary to create a "sense of well-being." By definition, this is a healthy environment. "Health is the state of complete physical, mental, and social well-being."

THE CHALLENGE OF PUBLIC SCHOOL FACILITIES—CHARLES YOUNG SCHOOL

Schools are not primarily environmental showcases. Schools are special environments that exist for the purpose of enhancing the learning process. They are sensitively built environments housing very special segments of the population. A sensitive environment refers to a place that supports the activities of segments of the population who are very young, very old, or who are experiencing illnesses. From an environmental health perspective, a sensitive environment, such as a school or day care facility, tends to be where adverse health effects manifest themselves in the face of unsanitary conditions.

In the United States there are about 120,000 schools providing for the educational needs of approximately 54 million students. On average, students receive about 20% of their environmental exposure in schools.

The importance of a healthy school environment's ability to enhance the learning process has been demonstrated in many studies. However, many school facilities throughout the United States, estimated at more than 50%, have environmental problems. Problems are mostly related to water damage, inoperable HVAC systems, and ineffective cleaning. Even though schools are the focus of constant public discussion, political attention, and government support, more effort is needed to emphasize and provide "healthy" school facilities by way of design, operation, and maintenance.

In many center-city schools, students and teachers far too often find themselves in a physical environment that adversely affects their morale, and, in some cases, their health and physical safety. The reason the Charles Young Elementary School case is so important is that until this study, there is scanty hard evidence to indicate that when a school building is in disrepair, student achievement suffers. More importantly, there are no cases that demonstrate greatly improved educational achievement when schools are restored in a thoughtful manner. In the case of Charles Young School, improvements in educational performance that have accompanied restoration have been exemplary.

There are many environmental health and safety requirements that all school facilities face. These include numerous fire safety codes, provisions for handicapped occupants, and numerous state and federal environmental statutes. However, the driving force behind successfully managing a school facility and its environment is not regulatory, or founded in government mandate. The real force behind a healthy school comes from the local community's commitment to a healthy school environment, free of distractions and detrimental health effects, so as to allow the learning process to move forward.

School districts too often are put in the position to postpone repairs and delay construction of new facilities to save money during periods of financial austerity. Unfortunately, learning excellence as measured in test scores alone tends to ignore the importance of the environmental quality in which learning takes place. Making cuts in routine cleaning and maintenance, repairs, and restoration is commonly considered less devastating than cutting academic programs. This limited thinking is very short-sighted, and, in the long run, ends up adding to the cost of education.

Public education is the responsibility of government. Children have no choice. The law requires that children go to school. School facilities are generally the local district's responsibility. It is a disappointing fact that state and federal mandates for educational programs to include school facility conditions are almost never accompanied by the funds needed to implement them. Districts must rely on the taxpayers' ability or willingness to help meet capital expenses. This results in glaring inequities in school environments among districts with different economic bases.

Facing their own budget shortfalls, state governments are often unable to offset school districts' mounting financial needs. Operation and maintenance costs are almost always cut first. The consequences of deferring maintenance include premature building deterioration accompanied by indoor air problems, increased repair and replacement costs, and reduced operating efficiency of equipment. The price tag for deferring maintenance continues to multiply (Hansen). Rising energy costs have also cut into the maintenance budget. When utility costs exceed the budgeted amount, 40 percent (40%) of districts in the nation report using funds earmarked for maintenance to meet energy-related expenses (Hansen).

The frequent cutbacks in maintenance and renovation coupled with widespread thoughtless, ineffective cleaning of school facilities in the U.S. sends a negative, uncaring message to students and educators. Their performance levels often mirror the message they receive from a deteriorated school facility. On the other hand, the enhanced management of school environments, to include renovation and cleanliness, sends a "we care" message to students, teachers, and staff. The evidence suggests that healthy environmental conditions shape attitudes and, eventually, positive performance.

A national survey conducted by the American Association of School Administrators found that 74 percent (74%) of school facilities should be replaced or repaired immediately. Twelve percent were identified as inadequate places of learning. In addition, recent reports from the US General Accounting Office indicate that public elementary and secondary schools throughout the country need over $100 billion to fix health, comfort, and safety problems in school buildings.

To address the crisis of deteriorating facilities, principals, superintendents, school business officials, school boards, and others are beginning to pursue innovative, grassroots solutions to the many challenges associated with maintaining school facilities.

AN EXAMPLE OF AMERICA'S CHOICE SCHOOL DESIGN

Charles Young Hill Top Academy is a school rich in Washington, DC, history. The school is located in the northeast corridor of the District. The school sits on a hill over-looking the Anacostia River. The school was built in 1931 and named after Colonel Charles Young, who was one of the first Afro-Americans to graduate West Point with a commission.

Today, Charles Young School has approximately 512 students enrolled and a faculty of 55. The enrollment fluctuates between 475 and 500 throughout the school year due to residency attrition. The students come from a wide range of family backgrounds. One hundred percent (100%) of the students are eligible for free breakfast and lunch.

Visitors, entering the school for the first time, immediately observe something very special about the school. It radiates a friendly energy directed at learning.

The school is in demand. For the last three years, Charles Young Elementary School has had a waiting list to register pre-school and pre-kindergarten students. Ten percent (10%) of the students are enrolled by special permission. Five percent (5%) of the students returned from charter schools. These students are enrolled at Charles Young because of the exemplary, unique, diverse academic program along with extra-curricular programs, committed teachers, staff, and a principal housed at the school.

Charles Young School was constructed as a traditional two-story school building. In 1975, the school was renovated into an open-space school. During the summer of 1997, Charles Young School was renovated again. Numerous environmental problems were corrected. Over 200 windows were replaced and new carpet was installed throughout the entire school.

In early 1997, the environmental conditions at Charles Young School were, by any environmental health standard, fully unacceptable. Throughout the building, water damage was evident. Water was entering the building constantly through numerous roof leaks, rotting windows, and broken steam pipes. On occasion, young students mistook escaping steam as an indication that the building was on fire. Mismanaged moisture caused visible mold growth on plaster walls, ceiling tiles, window frames, carpet and hard floors, and in ventilation ducts.

The HVAC system in the school was in disrepair. Most exhaust fans were broken, and the heating air-conditioning system did not work. Temperature fluctuated in ranges from 60 to 100 degrees F. Humidity levels often exceeded 90%.

Pest infestation was serious. Cockroach remains and fecal material were evident in all parts of the building. Birds had nested in the upper regions of the building interior and their droppings had seriously contaminated the air intakes of the HVAC system.

Floor surfaces throughout the building looked uninviting and worked against the educational benefits derived from open classrooms. Carpet surfaces could not be restored; they were extensively water damaged, worn, and separated. In many areas deteriorated carpet posed tripping hazards.

Hazardous materials and conditions also existed in the school. Peeling lead paint was found on window frames, doors, and stairwell banisters. Discarded unknown chemicals were leaking onto the floor in the school's mechanical room.

RESTORATION IS ESSENTIAL AND HAS MANY BENEFITS

Deteriorated environmental conditions in a school are guaranteed to worsen slowly in the face of unfunded maintenance, general mismanagement, and social turmoil. The environmental quality of a school is always symptomatic of school administrator attitude, public priorities, and institutional objectives.

Increasingly, communities are recognizing that deteriorated buildings of any type encourage looting, vandalism, arson, dumping, drug traffic, and other criminal use. Deteriorating schools are not immune from such conditions that stigmatize the entire community; automatically lowering the market value of any property associated with it, but, more importantly, any interest in learning. Over time, deterioration tends to migrate to adjacent facilities. These conditions add to a continuous cycle of economic and social depression.

"Topophilia" (love of place) is a word that has been used to describe the human affinity for a particular natural location. It is because of "topophilia" that

people stay in their communities and have a particular affinity for their schools. Using the "topophilia" concept, we can identify and describe those schools to which students and teachers are most attracted. For example, the most appealing environments tend to be those that are free from esthetically undesirable or discordant sights and influences. These environments often have a variety of interesting forms, textures, and patterns, and radiate a feeling of comfort and security.

Contrast that to deteriorated built environments. These environments can best be described as engendering "topophobia", or "fear of place." These environments tend to be so distorted and blighted that scenic qualities are mostly nullified or substantially reduced. These environments are more likely to result in abandoned properties.

Communities are beginning to be optimistic about their aging and often historic schools. On the positive side, these school facilities represent available community and social equity opportunities. The quality of a structurally sound old school building, even though deteriorated or degraded inside, can be made appealing through human intervention.

In general, successful restoration alleviates "topophobia", prevents the spread of contamination and blight, and halts the loss of urban aesthetics, image, and educational opportunity. School restoration is often the only way historical and cultural preservation, and community traditions can be ensured. Such restoration often results in the enhancement of human interaction, and information exchange. Finally, school restoration clearly protects health and the environment and corrects social and economic inequities. Quality of life is enhanced for the urban environment and often less effort is required to minimize pollution.

Prior to 1997, Charles Young was a school where nearly half the students were below national test averages for math and reading. In the minds of DC officials, there was an obvious link between students' environment and educational performance. The school facility was rapidly deteriorating. On top of that, students where constantly exposed to a surrounding neighborhood that faced a high level of social instability, unemployment, rising drug use, violence and crime rates.

A primary education challenge became that of defeating a rapidly evolving "no future" attitude on the part of young students and their parents, and replace it with a "bright future" attitude. It was very evident that if a high level of educational performance was to be attained, a positive change in the condition of the school environment had to also occur.

CHANGING COURSE

Federal Government and DC school officials recognized the need and made a serious commitment to make a dramatic change in the educational performance at Charles Young School, as well as many other schools in the city. A 1995 Presidential directive put into effect the Urban Schools Initiative. Charles Young School was chosen as the school revitalization demonstration project. The objective of the project was to:

- Turn a school building with acute indoor environmental problems into a model school environment.
- Assess the resources required for such work.
- Train District of Columbia Public Schools personnel in the prevention of future indoor environmental quality problems.
- Provide guidance to assist other schools in evaluating and correcting environmental problems based on the lessons learned in the remediation.

The Charles Young School project illustrates a simultaneous improvement in the quality of the school environment and educational performance that strongly suggests these positive changes are highly related, if not inexorably bound. Charles Young School is a classic example of highly effective stakeholder collaboration and "win-win" resource leveraging on the part of multiple stakeholders. The successful restoration of the school and the subsequent exemplary educational performance is due to collaboration of political and community leaders; government agencies, particularly EPA; District of Columbia Public Schools; dedicated teachers and school facility staff; numerous companies representing general contractors, environmental assessment and restoration, and the carpet industry.

CONDITIONS CORRECTED AT CHARLES YOUNG ELEMENTARY SCHOOL

The majority of the restoration tasks at Charles Young Elementary School were accomplished between June and September 1997. Two hundred and thirty-two windows were replaced to create brighter rooms and keep moisture and peeling lead paint out of the school. Throughout the school, lead paint was contained and removed. Roofing and brickwork were repaired to prevent water intrusion. Moldy and water-damaged materials were removed. Leaking ductwork, steam, and water pipes were replaced. Abandoned 55-gallon drums of chemicals in basement rooms were removed as hazardous waste. The basement area was decontaminated to eliminate residual chemical hazards. Pest management measures were instituted. Bird nests and dropping were

removed. Pest barriers were installed; and, food and water sources were removed.

The Carpet and Rug Institute, on behalf of several member companies, donated the replacement of over 45,000 square feet of carpet. Selected carpet floor coverings came from a variety of manufacturers and were matched to comfort, lighting, color and texture and sound control needs of rooms throughout the school.

Unique to this restoration project, the carpet industry provided training, maintenance schedules, and effective vacuums in addition to carpet cleaning equipment and supplies to sustain a healthy condition and inviting appearance of their product.

The HVAC system in the school required a major overhaul. The central fan system was made operational; fan motors were replaced as necessary. The chiller was replaced; new boilers were installed for heating; and exhaust systems were upgraded. Over 100 ventilators were overhauled through electrical repairs, parts replacement, and cleaning.

When the school year began in September 1997, young students entered a school that was clean, freshly painted, brightly lit, colorful, and environmentally healthy. "When the children returned to school, they were in awe. Excited, happy, and pleased to see a whole new school. The kids have a lot of pride in the school." (Dr Johnetta Smith, Principal).

Mr. Kenneth Ward, a teacher, summed up the effect of school's restored environment with the comment, "It's rejuvenating, with a fresh new comfortable feel. The children are excited to be here, excited about learning. It adds to a whole new, healthier school."

A PROACTIVE EDUCATIONAL PHILOSOPHY AND TEACHING STAFF

The most pristine school environment contributes nothing to the process of learning without a clear educational objective, the dedication of teachers and staff, and support of parents and community.

The faculty of Charles Young includes one principal, thirty-seven teachers, one counselor, one social worker, one library media specialist, one instrumental music teacher, one physical education/health teacher, one design coach, one literacy coordinator, one art teacher, one computer assistant instructor, two food service workers, five custodians, one security aide, one full-time nurse, two administrative aides, one registrar, and twelve educational aides.

These educators share a clear mission: *The Mission of Charles Young School is to provide and promote an exemplary student-centered learning*

environment that is standards-driven and requires actual student demonstrations of learning that holds all students to a standard of performance, and informs students of their expectations as they ultimately meet and surpass the national curricular standards.

During school year 1996-1997, Charles Young joined in partnership with Brown Junior High School, Phelps Career Center, and Spingarn High School and was awarded a DCPS Enterprise grant. This partnership provided for the implementation of the new Hilltop Academy. The Academy focuses on collaborative resources and technology as well as the acquisition of new skills, information, and multimedia opportunities. Charles Young's students reap the benefits by collaborating with outside organizations and taking advantage of a variety of opportunities. For example:

- **National Park Service (DARE):** A program designed to increase students' knowledge and awareness about substance abuse and to build student resistance to drugs. To teach children to say, "No" to drugs.

- **Writing to Read:** A program designed to improve reading and writing skills for all students through the use of journals, writing and keyboarding stations, listening centers, reading centers, and activity centers to help students' language skills on and off the computer.

- **Book It:** A program sponsored by Pizza Hut to encourage children to increase their ability to read through incentive awards given to students. Students learn to read for fun and pleasure and learn to read by reading.

- **Title I:** A school wide program funded by U.S. Department of Education for school reform and improvement to increase student achievement in all core areas, specifically reading and mathematics, for all students. The program provides educational opportunities to educationally deprived students by helping them to find success in the regular education program and attain grade level proficiency.

- **Language and Communications:** A program designed for special education students, aged 3 to 5, who have speech and language impairments. The program provides instruction and assistance in cognitive, social, physical, and emotional development.

- **Reading is Fundamental (RIF):** A program designed to increase students' love for reading as well as provide free books to students. Each student receives a minimum of three (3) books each school year.

- **Project Must:** A program designed to improve the level of math achievement of children in Grades 1-6. Direct instruction is emphasized to facilitate student interaction in the development of concepts. Students

learn to think and communicate in the language of math using manipulatives.

- **Music:** A program designed for all students that includes the Glee Club, Hand Bell Ensemble, keyboarding, drums, and the Male Chorus. The program builds student self-esteem, values, self-confidence, self-discipline, and multicultural awareness.

- **Interschool Sports Program:** An intramural program designed for competitive sport activities in basketball, football, volleyball, and tennis in the Elementary School Athletic League.

- **Cheerleaders:** A program designed for girls in grades 4-6 to practice teaming, sportsmanship, values, and competition.

- **Primary and Intermediate Learning Centers:** Programs designed to meet the challenge of students with special needs. Students receive intensive multisensory instruction on his/her instructional levels according to the IEP.

- **Junior G-man Program:** A program designed by the FBI to develop and enhance students' personal development through education. It helps to reduce drug demand by strengthening the ability to make good decisions.

- **Head Start:** A program designed for preschool ages 3 and 4. The program brings about a greater degree of social competence in children of low-income families. The child's entire family, as well as the community, must be involved.

- **Embassy Adoption:** A program designed to use the unique resources from the embassies in D. C. The program supports the sixth grade curriculum in the areas of social studies, world geography, mathematics, career development values education through innovative activities for students and teachers.

- **Work it Out/Talk it Out:** A program identified for fifth and sixth grade girls that is designed to teach student conflict resolution techniques and strategies.

- **Dear Celebrity Guest Reader, Read to Me My Friend, and The Book Exchange**: Four literacy programs that connect the school and home to increase student achievement in reading, as well as stress the importance and joy in reading. Guest readers come to the classes to read and discuss the stories with the children.

Educators and staff at Charles Young Hill Top Academy believe all children can learn. They understand the importance of knowing the learning style of each child as well as themselves. They promote excellence and stress the importance of values throughout the entire school system. The quality of education is of the utmost importance and teachers are held accountable. At Charles Young, educational excellence is accomplished by providing a practical and totally inclusive instructional program in all grades (pre- kindergarten through sixth grade).

Students at Charles Young are given the opportunity to have hands-on experience in the classroom. There is a high level of teacher student interaction. The teachers challenge their students to raise their level of critical thinking and learn that it's okay to question and ask why. Students are empowered to take risks and reach their highest potential.

In order to assure student success, the faculty and staff operate as one cohesive team, driven by a shared vision and guided by clearly defined goals. The principal is the instructional leader and manager who is supported by very strong parents and community groups in the total operation of the school.

Charles Young Hilltop Academy has become a paradigm of effectiveness and a community of caring. The school and community have readily accepted the joint responsibility for designing and maintaining a school of excellence with shared values for all stakeholders.

The instructional program is guided by effective school research and has therefore successfully established a school culture of inquiry where the faculty continuously examines and improves the quality of teaching, learning, and school leadership. Charles Young is an educational institution where the students study not only what they are learning in the curricular sense, but also their own capability as learners. The instructional program is based on problem situations through communication, reasoning, and problem solving. Evaluation is used as a means of instruction, learning, and programs.

ENVIRONMENTAL QUALITY RELATED TO EDUCATIONAL PERFORMANCE

Until now there has been limited opportunities to measure educational performance in relation to a healthy school environment. Charles Young School provides that opportunity.

There are several measures for evaluating environmental and educational performance in schools. Environmentally we can measure temperature, humidity, and noise levels. We can measure cleaning effectiveness and sanitation levels especially for IAQ, bacteria and mold. We can look at health and accident reports. Educationally we typically measure long-term academic achievement in math and reading. We can also measure absenteeism, student perception of the

school environment, discipline incidents, and parent involvement and support. We can measure teacher attitudes, retention and transfer rates.

Table 1. General Environmental Factors

Environmental Factors	Before Restoration	Post Restoration Y 2000	Observation
Temperature and Climate	Broken HVAC, 60°-100° F, steam leaks, ineffective ventilation	Comfortable 68° - 72° F Controlled humidity	New HVAC system effective in achieving comfortable temperature
Lighting	Many dim areas and widespread glare	Well lighted school and reduced glare	New windows and soft flooring reduce glare
Health and Safety Hazards	Electrical hazards Trip hazards	No hazards	Restoration removed all known hazards
Teaching Space	Space limited by deterioration and unsanitary surfaces	Open, flexible use of all surfaces	Much flexibility in teaching space achieved by restoration
Maintenance Practices	Maintenance was ineffective in the face of widespread deterioration	Scheduled, effective equipment, attention to extraction, safe disinfectants	Motivated staff, cleaning plan and schedule, effective technique and equipment achieves a constant sanitary condition
Furnishings and Decor	Generally uninviting	Colorful, soft and appealing	New furnishings create a high sense of comfort and well-being
IAQ	Lead, high dust, toxic VOC	No toxic pollutants, fully acceptable air quality	See table 2
Biopollutants	Excessive mold, bacteria, allergens	No or very low biopollutant levels detected	See tables 2-4

The school and its educational strategy depend on an environment that is attractive, comfortable, open, and free of glare and noise. The inviting open classroom design of Charles Young Schools has been demonstrated to provide a well lighted, comfortable environment, highly effective in developing the educational performance of students.

Carpet floor coverings are essential in making the classrooms work. For example, student reading skills have greatly improved because of open classes and flexibility of teaching associated with total usable space that includes the floors. An ability to communicate between student and teacher is possible only with good sound control. Classrooms at Charles Young have estimated sound levels that range been 58 and 65 db. Normal speech can be easily heard throughout the school building. The use of carpet in the Charles Young School makes satisfactory sound control simple and economical to achieve. Research has shown that "without carpet, effective sound control in open space classrooms is virtually impossible to achieve" (School Facilities and Transportation Division, State of California, 1986).

The school environment is healthy and sanitary as measured by standard public health methods. A summary of air and other environmental data, collected on behalf of the Carpet and Rug Institute for the school year 1998-1999, strongly suggests that the indoor environment of Charles Young School is properly maintained and exhibits no signs or traits of an unsanitary environment or of an IAQ problem building.

Maintenance of the school emphasizes effective vacuuming and regularly scheduled extraction cleaning of all parts of the building, including carpet. This program is highly effective in keeping the school building healthy.

Extensive environmental data collected three times during the school year 1998-1999 included all the biopollutants that have the greatest health risks indoors; fungi, gram negative bacteria, and cat, mite, and cockroach allergens. Respirable suspended particulate matter and total volatile organic compounds (TVOC) were also measured. Numerous measurements were taken in the surrounding outside environment throughout the school building.

Table 2 illustrates data collected in the most health-sensitive portions of the building; the fully carpeted pre-k kindergarten area and the lunch room which has a hard floor surface. In addition, no region of the building indicated significant deviation from acceptable environmental quality levels such as those shown in Table 2. IAQ levels, none of which would indicate a problem, tended to be higher over hard surfaces than over carpet. This finding reinforces and validates the decision to replace carpet throughout the building for comfort and noise control.

Table 2. Summary of Environmental Quality for School Year 1998-1999

Location	June 1998	December 1998	June 1999	Observation
Outdoor AQ Fungi	460-780 CFU/m^3	490 CFU/m^3	610-1020 CFU/m^3	Normal range no dominant species
IAQ Fungi Over Carpet (Pre-K)	250-260 CFU/m^3	180-240 CFU/m^3	670-1640 CFU/m^3	Normal range no problem in relation to outside
IAQ Fungi Over Hard Floor(Lunch R)	270-720 CFU/m^3	440 CFU/m^3	290-510 CFU/m^3	Slightly higher counts than over carpet
Fungi Carpet Surface Pre-K	<20 CFU/cm^2	<20 CFU/cm^2	<20 CFU/cm^2	Normal
Fungi Hard Floor Surface	<20 CFU/cm^2	<20 CFU/cm^2	< 20 CFU/cm^2	Normal
Outdoor AQ Bacteria	<10 CFU/m^3	10 CFU/m^3	20 CFU/m^3	Normal
IAQ Over Carpet Bacteria	40 CFU/m^3	<10 CFU/m^3	<10 CFU/m^3	Normal in relation to outside
IAQ Over Hard Floor Bacteria	210 CFU/m^3	20 CFU/m^3	40 CFU/m^3	Normal but higher than carpet
Bacteria (gnb) Carpet Surface	<4 CFU/cm^2	<5 CFU/cm^2	< 5CFU/cm^2	Sanitary
Bacteria (gnb) Hard Floor	23 CFU/cm^2	<5CFU/cm^2	<5CFU/cm^2	Unsanitary 6/98 measurement
RSP Outdoors	35 ug/m^3	22ug/m^3	29ug/m^3	Normal City RSP AQ
RSP Over Carpet	33 ug/m^3	15ug/m^3	32ug/m^3	Normal RSP IAQ in relation to outside
RSP Over Hard Floor	64 ug/m^3	40 ug/m^3	40ug/m^3	Elevated, <40 desirable
TVOC Over Carpet	31.4 ug/m^3	152 ug/m^3	35.6 ug/m^3	No problem likely
TVOC Over Hard Floor	24.1 ug/m^3	93.6 ug/m^3	87.9 ug/m^3	No problem likely
Airborne Cockroach Allergen(Pre-K)	<0.01 U/m^3	<0.01 U/m^3	<0.02 U/m^3	No problem likely for any allergen(cat, mite, cockroach)

*Collected and Submitted to the Carpet and Rug Institute by Air Quality Sciences, Inc., 1999.

High levels of housekeeping and maintenance are essential in making the classrooms work. In August 2001, prior to the school year cleaning of the facility, a cleaning effectiveness analysis was conducted throughout the building with a focus on the sanitation condition of flooring. A pre-sampling investigation found there was no health complaints related to the building in any way. There were no indications of IAQ problems or student or teacher health responses to allergens. An environmental cleaning effectiveness sampling technique used widely

throughout the food sanitation and food processing industry was applied throughout the building to a variety of flooring materials prior to their cleaning. The sampling methods for both bacteria and fungi are economical but, at the same time, highly effective in detecting unsanitary conditions as indicated by gram negative bacteria and mold growth.

Table 3. Fungi Analysis
Charles Young School, August 2001

Location	Before Cleaning	After Cleaning	Observation
Auditorium Carpet	<5 CFU/cm^2(Yeast)	<3 CFU/cm^2(Yeast)	High humidity is cause of yeast
Hard Floor Hallway 1st Floor	5 CFU/cm^2(Yeast)	N/A	Carpet and hard floor levels were equivalent
Principle's Office Carpet	5 CFU/cm^2(Yeast)	<2 CFU/cm^2(Yeast)	No problem
Open Class 2nd Floor Carpet South w/ failed humidifier	6 CFU/cm^2(Yeast)	< 4 FU/cm^2(Yeast)	No problem
Open Class 2nd Bay Carpet South Side	6 CFU/cm^2(Yeast)	n.d.	Cleaning highly effective in removing yeast
Hard Floor Hallway 2nd Floor	6 CFU/cm^2(Yeast)	N/A	2nd floor carpet and hard floor yeast levels equivalent

Table 4. Gram Negative Bacteria Analysis
Charles Young School, August 2001

Location	Before Cleaning	After Cleaning	Observation
Lunch Room	n.d.	N/A	Very Sanitary
Principle's Office Carpet	1 CFU/cm^2	n.d	High traffic area but very clean before cleaning
Open Class 2nd Floor Carpet South	1-3 CFU/cm^2	3 CFU/cm^{2*}	Small section of carpet cross contaminated with condensation water
Open Class 2nd Floor Carpet South w/ failed humidifier	6-8 CFU/cm^2	1 CFU/cm^2	Carpet cleaning reduced bacteria count

(*At the time samples were collected, a dehumidifier malfunction released contaminated water on to a small portion of the carpet floor. This water contained high levels of gram negative bacteria. The problem posed no health risk and was corrected, but this event shows the need to keep all parts of an environment clean and dry and free of water intrusion.)

Levels of measured bacteria and yeast exhibit no sign of an unsanitary or problem building, even at a time when the building's cleaning state was stressed by a year of continuous use and at a time in the Washington, DC, summer when relative humidity levels remained at levels in excess of 90%.

BEHAVIORS AND ATTITUDES AND TEST RESULTS

Since the restoration at Charles Young Elementary School, the school radiates a sense of well-being. It is widely reported by teachers and staff that many students are reluctant to leave in the afternoons because they like the school environment that many call a "safe haven". Teachers and staff, throughout the school district and in the school, want to remain there, and many of the best teachers at the school have elected not to retire. The restored school is the pride of the community. Parents visit the school more often, and some even take classes in reading. The District of Columbia is using Charles Young Elementary as the model for restoring 9 other schools in DC.

Table 5. Attitudes and Behaviors Analysis

Behaviors and Attitudes	Before Restoration Y1996	Post Restoration Y 2001	Observation
Student Attendance	89%	93%	A positive change of 1-2% is highly significant for center city schools
Student Attitude	Somewhat frightful and apprehensive	Happy, energetic, and optimistic	Many students are returning from private and magnet schools
Teacher Attitude	Frustrated to apathetic	Very positive, proactive, and optimistic	Teachers are willing to spend extra time and energy in helping student learn develop and skills
Teacher Retention	Normal to low retention and retirement	Very high retention, few retirements	Teachers from throughout DC are applying for positions
Staff Attitude	Sought retirement	Prideful and delayed retirement	There is obvious satisfaction in being identified with the school
Parent Involvement	Low	High	Many parents are using the school after hours to improve their own reading skills
Community Use	Low	Frequent	Many community events take place in the restored school
Community Image	Deteriorated facility suitable for closure and demolition	Model for other 9 DC schools	Restoration has retuned to the community a rich part of heritage
Student health complaints	Frequent	Infrequent-Normal Very much reduced	Although difficult to quantify, there is a qualitative indication of reduced asthma attack rate

The inviting features of the school have been an attention getter and have measurably contributed to educational achievement. Students cannot learn if they do not attend school. Attendance is up from levels that existed prior to the restoration. Attendance has risen from 89% to 93%. Teachers report that students often will not leave the school in the afternoons voluntarily. They like their school, which is commonly referred to as a "safe haven."

Prior to the restoration, many parents in the community moved their children to private and special schools throughout the area. Since the restoration, many of these students have returned to Charles Young School, and many students from other schools throughout the district are seeking admission.

One common indicator of a high performance school is that good teachers want to be there. Since the 1997 restoration, teacher turn-over has been extremely low. Not only are good teachers retained, but the very best teachers throughout the DC School District are requesting transfers to Charles Young Elementary School. In addition, school facility and support staff enjoy their new surroundings and in recent years have elected not to retire.

High performance schools are the center of community life and are used for educational purposes well beyond the regular school schedule. One very noteworthy aspect of the recent renovation at Charles Young Elementary School is that parents increasingly use the school and many take classes in reading to enhance their own skills and relate better to their children and their progress in school.

TEST SCORES--THE BOTTOM LINE OF MODERN EDUCATION

The mergence of a healthy school environment and a proactive educational philosophy has produced exemplary educational results. Charles Young Hill Top Academy represents high performance education. An analysis of test results shows that the school is much more than an indoor environmental showpiece.

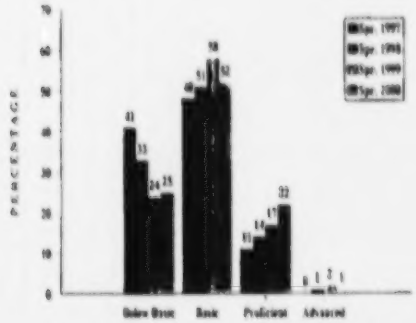
Since the restoration in 1997 there have been many remarkable and documented improvements in the common measures of academic performance.

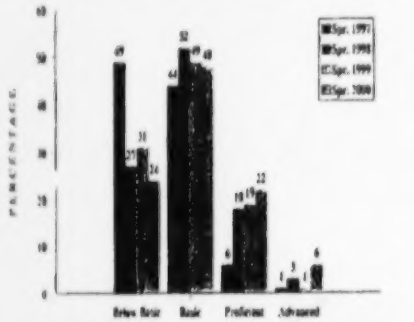
Table 6. National Test Results

Standard Test Results	Before Restoration Y1996	Post Restoration Y 2000	Observation
Math Scores Below Basic	49%	24%	25% of non-performing students have been motivated
Math Scores Basic or Above	51%	76%	Accessible computer technology has enhanced math skills
Reading Scores Below Basic	41%	25%	Reading improvement suggests better mental concentration
Reading Scores Basic or Above	59%	75%	Open classroom communication, comfortable space, noise control, lighting enhance reading skills

Test scores, as measured by the Stanford 9 Math and Reading, are up significantly. Each year since the 1997 restoration of Charles Young Elementary School, standardized test scores have risen at the school. Prior to the restoration, nearly half of all students scored in the bottom quartile of the national test scores. Since the restoration, well over half of the poorly performing

students rose to national average attainment levels. Over twenty-three percent of all students score well above national averages in standardized testing.





CONCLUSIONS

The primary objectives of the Urban Schools Initiative have been met. Charles Young Elementary School has been successfully restored to a healthy environment and is now serving as a model for other schools. The school building with acute indoor environmental problems has been transformed into a model school environment. The correct private and public resources were acquired and applied. The essentiality of continuous cleaning, maintenance and repair for the prevention of future indoor environmental quality problems has been demonstrated. The Charles Young School experience is guiding and assisting other schools in evaluating and correcting environmental problems based on the lessons learned in the remediation.

The most important result in this restoration example is not the measured improvement in environmental quality. It has been measured and documented that educational performance and achievement has risen dramatically at the school. It is the demonstration that there is a direct connection between healthy school environments, behaviors and attitudes of students, parents, and educators; and academic performance and achievement.

REFERENCES AND NOTES

Andrews, James, and Richard Neuroth. Environmentally Related Health Hazards in the Schools. Paper Presented at the Annual Meeting of the Association of School Business Officials International. Detroit, MI, Oct. 1988. ERIC ED 300 929.

Andrews and Neuroth discuss the health risks associated with inadequate indoor air quality, which have a greater effect on children than adults. They provide historical background to indoor air quality issues and outline the reasons to be concerned about poor air quality in schools. Andrews and Neuroth assert that school facility planners have a moral obligation to do everything possible to mitigate conditions that may contribute to poor indoor air (5).

Berner, Maureen. Building Conditions, Parental Involvement, and Student Achievement in the District of Columbia Public School System. Urban Education 28.1 (1993): 6-29.

Berner presents a case study of public schools in Washington, D.C. She found that parental involvement affects the physical condition of schools, and building conditions affect student academic achievement scores. The statistical evidence from this study supports Berner's contention that, if buildings are in poor condition, students can be expected to reflect their negative environment (17). Thus, inferior surroundings negatively affect students' academic performance.

Bowers, J. Howard, and Charles Burkett. Relationship of Student Achievement and Characteristics in Two Selected School Facility Environmental Settings. Paper Presented at the 64th Council of Educational Facility Planners, International Conference. Edmonton, Alberta, Canada, Oct. 1987. ERIC ED 286 278.

Bowers and Burkett summarize their research on the effect of the environment on students, concluding that a significant difference existed between students at the two elementary schools in regard to the relationship of the physical environment and student achievement (12). Students performed significantly better on various academic tests in the newer school building as compared to those students in the older facilities. Higher attendance, decreased incidents requiring discipline, and better health were also documented among students in the more modern school.

Bartholomew, Robert. The Physiological and Psychological Effect of the Educational Environments on Human Performance. Monticello, IL: Council of Planning Librarians, 1976 (Exchange Bibliography # 1049).

Bartholomew puts forth a bibliography of resources for improving school environments with the aim of improving student learning. He states the physical environment has considerable impact on the educational achievements, well-being and performance of the students (2).

Baechler, M. C., et al. (10%), Sick Building Syndrome - Sources, Health Effects, Mitigation, Noyes Data Corporation, Park Ridge, NJ, 1991.

Berner, Maureen M., *Building Conditions, Parental Involvement, and Student Achievement in the District of Columbia Public School System*, Urban Education, Vol 28 No1, p 6-29, April 1993.

Berry, Michael A. et al. "*Suggested Guidelines for Remediation of Damage from Sewage Backflow into Buildings*", Journal of Environmental Health, Vol. 57, No. 3, October 1994.

Berry, Michael A., Protecting the Built Environment--Cleaning for Health, TriComm 21st Press, Chapel Hill, NC, 1993.

Berry, Michael A., "Assessing the Risks of Indoor Air", in Indoor Air Quality in Homes: Synthesizing the Issues and Educating Consumers, pp. 17-21, American Association of Housing Educators and Building Research Council-Small Homes Council, University of Illinois at Urbana-Champaign, 1991.

Berry, Michael A., "Indoor Air Quality: Assessing Health Impacts and Risks", International Symposium Industrialization and Emerging Environmental Issues, University of Occupational and Environmental Health, Kitakyushu, Japan, October, 1989.

Canter, David, and Peter Stringer. Environmental Interaction. New York: International Universities Press, 1975.
This is a wide-ranging book that deals with numerous issues related to environmental psychology, examining the complex array of interactions which people have with their physical environment(13). Canter, Stringer and the other contributors to Environmental Interaction investigate how the physical environment affects people. While not written exclusively about schools, many of the specific factors addressed apply to the school environment, including climate (temperature, humidity and ventilation), light, noise and spatial layout. A number of the broader themes discussed are also relevant to the school environment, such as the need for considering how specific factors interact with each other. Overall, the authors argue that physical surroundings have both physiological and psychological effects on humans.

Capell, Lee, and Frank Lewis. Caring for the Indoor Environment in Southern Schools.Enviros7.51997).http://www.envirovillage.com/Newsletters/Enviros/N07_05.htm
Capell and Lewis characterize poor indoor air quality in schools as a serious problem that harms students' health and learning. They estimate that roughly 19% of U.S. schools have indoor air quality problems, affecting over 8.4 million students. Capell and Lewis provide a number of reasons that schools should

focus on improving indoor air quality, including gains in student and teacher productivity, reduced health problems and lower costs.

Chan, Tak Cheung. A Comparative Study of Pupil Attitudes Toward New and Old School Buildings. Greenville, SC: Greenville County School District, 1982. ERIC ED 222 981.

Chan describes his study of student attitudes regarding their schools, in which he contrasted data collected from a new school with data from older schools. He concluded that students attending the modern school hold far more positive views of their surroundings than those attending the older schools. Chan believes the finding is important for the following reason: positive pupil attitudes produce positive pupil performance and behavior, while negative attitudes contribute to impaired learning and behavioral problems (1).

Chan, Tak Cheung. Physical Environment and Middle Grade Achievement. Greenville, SC: Greenville County School District, 1980. ERIC ED 198 645.

Chan hypothesizes a link between the condition of school facilities and student achievement. This revised version of Chan's 1979 study on the effect of building age on pupils reports on the same basic research into the physical environment's impact on 8th graders' achievement. However, in this paper, he further breaks the data down and examines the impact of air conditioning, carpeting, and lighting and color choices on academic performance.

Chan, Tak Cheung, and Garth Petrie. The Brain Learns Better in Well-Designed School Environments. Classroom Leadership Online 2.3 (1998). http://www.ascd.org/pubs/cl/2nov98.html

Chan and Petrie review recent developments in brain research as they pertain to learning environments. They address issues such as the need for adequate ventilation, aesthetically pleasing facilities, proper color and lighting, comfortable temperatures and quiet surroundings. Chan and Petrie summarize by stating, "The significance of the learning environment cannot be underestimated."

Christie, Daniel, and Carl Glickman. The Effects of Classroom Noise on Children: Evidence for Sex Differences. Psychology in the Schools 17.3 (1980): 405-408.

Christie and Glickman found that children's performance of many classroom tasks will vary as a function of classroom noise levels (408). They note that boys usually thrive in a noisier environment, while girls learn better in less noisy surroundings.

Earthman, Glen, and Linda Lemasters. Review of Research on the Relationship Between School Buildings, Student Achievement, and Student Behavior. Paper Presented at the Annual Meeting of the Council of Educational Facilities Planners, International. Tarpon Springs, FL Oct. 1996. ERIC ED 416 666.

Earthman and Lemasters present a research review focusing on the effect of school physical environments on student performance. They state that every study they describe clearly shows a relationship between student performance, both achievement and behavior, and the condition of the built environment . Earthman and Lemasters argue it is essential to invest in improving the built environment of schools as a means of improving pupil achievement and behavior.

Earthman, Glen, and Linda Lemasters. Where Children Learn: A Discussion of How a Facility Affects Learning. Paper Presented at Virginia Educational Facilities Planners Annual Meeting. Blacksburg, VA, Feb. 1998. ERIC ED 419 368.

Earthman and Lemasters review some of the key research into how school facilities affect student performance. They conclude that student achievement is higher when windows, floors, heat, roofs, locker conditions, ceilings, laboratory conditions, age of the facility, lighting, interior paint, mopped floors, cosmetic conditions in general were rated above standard by school staffs. The attitude and behavior of pupils is also affected by these factors.

Earthman, Glen, and Carol Cash, and Denny Van Berkum. A Statewide Study of Student Achievement and Behavior and School Building Condition. Paper Presented at the Annual Meeting of the Council of Educational Facilities Planners, International. Dallas, TX, Sept. 1995.

Earthman, Cash and Berkum examine the connection between school building condition and pupil achievement and behavior in North Dakota high schools. Their results indicate that, there is a relationship between the condition of a school building and the performance of students on achievement tests, although the precise nature of the link was not determined.

Freiberg, H. Jerome, ed. School Climate : Measuring, Improving and Sustaining Healthy Learning Environments. Philadelphia, PA: Falmer Press, 1999.

This book is composed of chapters authored by experts across the globe from several different disciplines. The work defines school climates broadly and inclusively with a focus on social/psychological factors such as student and teacher perceptions of their surroundings, parent and community involvement and leadership styles. Though mentioned less frequently than the more abstract social/psychological climate measures, the book also incorporates aspects of schools physical environments (lighting, temperature, cleanliness, etc.). Freiberg states that climate has clear implications for achievement and academic well being.

Frazier, Linda. Deteriorating School Facilities and Student Learning. ERIC Digest 82 (1993). ERIC ED 356 564.

Frazier states that teachers and their pupils often work in a physical environment that adversely affects their morale, and, in some cases, their health. She mentions factors such as run-down physical facilities and problems with indoor

air quality. Frazier argues that problems associated with inadequate indoor air quality are particularly concerning, since they impair students' concentration and diminish their health.

Franke, Deborah L., et. al., *Cleaning for Improved Indoor Air Quality: An Initial Assessment of Effectiveness,* Indoor Air, The International Society of Indoor Air Quality and Climate, Vol 7: 41-54, 1997.

Green, George. Ah-choo! Humidity Can Help. The American School & University Sept. 1979: 64-65.
Green uses a variety of field data to argue that maintaining proper humidity in schools can greatly reduce sickness. He points out that decreased incidence of sickness would lead to lower rates of absenteeism. Higher attendance would presumably lead to more productivity and, therefore, increased learning.

Hathaway, Warren. Educational Facilities: Neutral With Respect to Learning and Human Performance? CEFP Journal July-Aug. 1988: 8-12.
Hathaway asks what signals school buildings send to the students who inhabit them. Factors including air quality, color, light, noise and temperature and their physiological and psychological effects on humans are discussed. He concludes, "In all probability, educational facilities have closely coupled relationships to learning and human performance (12)."

Hathaway, Warren, et al. A Study into the Effects of Light on Children of Elementary School Age--A Case of Daylight Robbery. Edmonton, Alberta, Canada: Alberta Department of Education, 1992. ERIC ED 343 686.
This paper presents the findings from a study of the effect of different lighting systems on pupils. Data were gathered over the course of more than two years, and the effects of four lighting systems were compared. One central finding was that students who attended class in an environment that included ultraviolet light supplements had better attendance and academic performance, increased physical development, and lower dental cavity rates than those pupils who did not receive extra ultraviolet light. The authors concluded that lighting systems have effects on pupils beyond mere illumination of the classroom.

Hansen, Shirley J., School Houses in the Red. A Guidebook for Cutting Our Losses: Powerful Recommendations for Improving America's School Facilities Arlington, Virginia: American Association of School Administrators, June 1992. 47 pages. ED 347 697.

King, Jonathan, et al. The Physical Environment and the Learning Process. Ann Arbor: The University of Michigan, 1979.
King, et al. present a literature review and analysis of the research on the relationship between the behavior of individuals and their educational environments. Specific factors discussed in this literature review include acoustics, climate, color, and lighting. King, et al. conclude that climate

(temperature, humidity and air circulation) and acoustics do seem to significantly affect academic achievement and task performance. They state that the effects of color and lighting are less clear, although likely significant.

Kuller, Rikard, and Carin Lindsten. Health and Behavior of Children in Classrooms With and Without Windows. Journal of Environmental Psychology 12 (1992): 305-17.
In this Swedish study, Kuller and Lindsten evaluate the effects of natural light versus fluorescent light on school children in the areas of production of stress hormones, classroom performance, body growth, and sick leave . Their results indicate there is sufficient evidence of the importance of natural light in the schools and the potential harmful effects of windowless surroundings.

Lewis, Anne, and others. Wolves at the Schoolhouse Door. An Investigation of the Condition of Public School Buildings. Washington, D.C.: Education Writers Association, June 1989. 64 pages. ED 306 660.

McGuffey, C.W. Facilities. Improving Educational Standards and Productivity. Ed. Herbert Walberg. Berkeley: McCutchan, 1982. 237-281.
McGuffey's chapter is a research review focusing on the ways educational facilities affect student achievement, performance and self-concept. The specific factors investigated in his literature review include school building age, temperature, lighting, color, noise and building maintenance. McGuffey acknowledges that the range of sources reviewed is broad, and it is sometimes difficult to draw uniform conclusions from such disparate materials. Nonetheless, McGuffey was confident enough in the data to contend that the above factors do impact student outcomes.

Meek, Anne, ed. Designing Places for Learning. Alexandria: Association for Supervision and Curriculum Development, 1995.
Meek introduces the book by stating that it illustrates ways of looking at schools as places of deep meaning and shows how that view of schools can alter our approaches to designing, constructing, and renovating the buildings we inhabit (vi). The chapters that follow focus on topics such as using architectural planning as a means of school reform, designing buildings that facilitate learning and a positive social environment, and how to revamp older schools. Many case studies are presented to illustrate the effect that the physical environment has on students academic and behavioral outcomes.

Maroni, M., et. al, Indoor Air Quality, Elsevier, Amsterdam, 1995. North Atlantic Treaty Organization, "Overview to Indoor Air Sampling Technologies", in : NATO/CCMS Pilot Study on Indoor Air Quality-Sampling and Analysis of Biocontaminants and Organics in Non-Industrial Indoor Environments, NATO, May 1992.

Maslow, A.H., and N.L. Mintz. Effects of Esthetic Surroundings: I. Initial Effects of Three Esthetic Conditions Upon Perceiving Energy and Well-being in Faces. Journal of Psychology 41 (1956): 247-254.
Maslow and Mintz's study examines the effect of beautiful, average, and ugly rooms on people. They find that the more aesthetically pleasing the room, the higher the ratings of energy and well being reported by subjects tested.

Myhrvold, A.N., and E. Olsen. Pupil's Health and Performance Due to Renovation of Schools. Healthy Buildings/IAQ 1997: 81-86.
Myhrvold and Olsen describe a Norwegian study of how the conditions of indoor environments, including indoor air quality and room temperature, affect students. Their results support the hypothesis that a good indoor environment in schools...promote[s] the pupils' health, well-being and performance as measured by a reaction time test.

NICHD Early Child Care Research Network. Characteristics of Infant Child Care: Factors Contributing to Positive Care giving. Early Childhood Research Quarterly 11 (1996): 269-306.
This National Institute of Child Health and Human Development article describes a study seeking to identify factors that facilitate quality child care. One of the four key structural factors associated with infants receiving sensitive, warm, responsive care from their caregivers was physical environments [that] appeared safe, clean, and stimulating.

Sinofsky, Esther, and Frederick Knirk. Choose the Right Color for Your Learning Style. Instructional Innovator Mar. 1981: 17-19.
Sinofsky and Knirk discuss the need to utilize principles of environmental psychology in order to help facilitate, rather than inhibit, learning. They focus on the potential impact of building interiors and exterior color schemes on attitudes, behaviors and learning.

Pierson, T. K., M. A. Berry, D. F. Naugle, " Application of a Risk Characterization Framework for Review of Indoor Air Quality Risk Estimates", in The Fifth International Conference on Indoor Air Quality and Climate, Vol. 1, pp. 453-458, Toronto, Canada, August, 1990.

Poyser, Larry. An Examination of the Classroom Physical Environment. Indiana University at South Bend, 1983. ERIC ED 251 954.
Poyser reviews literature relevant to the effect of the physical environment in schools on students. He compiles a broad array of evidence investigating the impact of the classroom's physical environment on...students' ability to learn. The writings Poyser amasses provide support to the theory that physical surroundings play a major role in students' overall learning experience. Poyser's literature review covers broad topic areas (ranging from psychology to design), as well as specific elements of the school physical environment such as

classroom layout (including seating arrangement), color, heating, lighting and noise.

Proshansky, Harold, William Ittelson, and Leanne Rivlin, eds. Environmental Psychology: People and Their Physical Settings. New York: Holt, Rinehart and Winston, 1976.

This work serves as an overview of issues relevant to environmental psychology and is composed of a broad range of readings on topics related to the field. The introduction states that all organisms engage in a complex interchange with their environments in the course of which they modify, and are modified by, what they encounter. This viewpoint is a useful foundation through which environmental psychology can be understood, including the effect of the school environment on pupils. The school environment is not specifically addressed in much depth in Environmental Psychology, but the fundamental themes regarding the multiple ways in which the environment affects human behavior are relevant.

Sleeman, Phillip, and D.M. Rockwell, eds. Designing Learning Environments. New York: Longman, 1981.

This book covers a broad spectrum of school design planning issues, from site selection to technology usage. It includes several chapters that are closely related to the physical environment's effect on learning. Areas discussed in these sections of the book include controlling noise levels, providing sufficient and appropriate lighting, and ensuring proper temperature, humidity and ventilation levels.

State of California, School Sound Level Study, School Facilities and Transportation Division, California State Department of Education, 1998.

An ability to communicate between student and teacher is possible only with good sound control at range been 58 and 65 db. At these levels normal speech can be easily heard throughout the school building. Beyond 67db, distraction occurs. This research shows that without carpet, effective sound control in open space classrooms is virtually impossible to achieve.

The University of Georgia School Design and Planning Laboratory Web Site. http://www.coe.uga.edu/sdpl/sdpl.html

This Internet site includes a variety of short articles and literature reviews regarding the effect of the school environment on student learning. Topics discussed include school building age, lighting, color, aesthetics, temperature, acoustics and physical facility design. The broad theme throughout these articles is that the environment plays a major role in pupil (and teacher) attitudes and behaviors, and ultimately that surroundings affect learning.

Weinstein, Carol, and Thomas David, eds. Spaces for Children: The Built Environment and Child Development. New York: Plenum, 1987.

Spaces for Children uses the idea that the immediate environment is the primary medium for learning as a segue into a more detailed investigation of the topic.

The book examines how children interact with their surroundings and then seeks to apply this knowledge to the design of schools and other spaces for children. The first section of the book introduces specific issues such as place identity/belongingness and cognitive development, as well as broader environmental themes. The second section offers a framework upon which to design spaces for children. Weinstein, David and the other contributors' overall argument is that the physical environment has a tremendous effect on children's development.

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